INAUGURAL MEETING OF THE BIRMINGHAM GRADUATE SECTION.

THE Inaugural Meeting of the first Graduate Section of the Institution was held at the Grand Hotel, Birmingham, at 7-30 p.m. on Wednesday, 5th April, 1933. Mr. J. A. Hannay, Member of Council, was in the chair, and the attendance of close on 100 included the following: Messrs. A. J. Aiers, J. A. Boyes, J. D. Scaife, H. E. Weatherley, and R. H. Youngash (Members of Council); Dr. Anderson (Principal), Birmingham Central Technical College, Messrs. T. E. Dodds, J. France, and R. Hazleton (General Secretary).

Mr. J. France (Hon. Secretary, Birmingham Section), read letters wishing the new Section success, from: Sir Herbert Austin, Sir Alfred Herbert; Messrs. Thornycroft, Carlton-Smith, Hales, Hutchinson, Ferguson, Dormer, Locker, Jones, Frazer, Hey, Hartley, Hancock, Drane, Field, Pate, and Perry-Keene.

Before formally proposing the inauguration of the new Section, Mr. Hannay gave a brief survey of the work done by the Institution. He observed that they were, at this meeting, making history, and prophesied that those members present would, in the years to come, look back with pleasure on their presence at the Inaugural Meeting of the Graduate Section in Birmingham.

They were glad that one of the gentlemen who had been partly responsible for the inauguration of the Institution, Mr. Scaife, was with them that evening. They had also heard letters read from Mr. Hutchinson, who was credited with the honour of founding the Birmingham Section; from Sir Alfred Herbert, the next President; from Mr. Tom Thornycroft; and from the President (Sir Herbert Austin).

Mr. Hannay referred, in passing, to the hard work done by Mr. Wright in getting the Birmingham Section into shape in the early days, and to the help given to him by Mr. Groocock, and later by Mr. Youngash. These gentlemen had set a very good example for the Graduates to follow, and the members were looking forward to seeing something very good.

The loss of an old friend of the Institution, Mr. H. Mantell, who died some days previous to the Meeting, was referred to by Mr. Hannay, who spoke with appreciation of his work in putting before the Council the scheme for the Graduate Examination; of his assistance in getting out the JOURNAL at a time when they had not

a General Secretary ; and of his part in forming the Examinations Committee. He had finally been Chairman of the Examinations and Research Committee. It was greatly to be regretted that he should have passed away just at a time when he might have seen the completion of his work for the Graduate Section.

Continuing his survey of the history of the Institution, Mr. Hannay said that it had soon been found that something would have to be done for the young men, and the Council had decided that a start should be made in Birmingham.

The matter had been referred to the Birmingham Committee, through their President, Mr. Youngash, and under his guidance, preparations had been made, and Graduates in that district had been invited to meet the Committee. After that, Mr. Hannay said, the Graduates had taken matters into their own hands, held preliminary meetings, and they were there that night determined to start the Section.

Mr. Hannay then formally proposed " That a Graduate Section of the Institution of Production Engineers be formed in Birmingham."

Mr. J. D. Scaife said that he looked upon it as a very great honour to second the motion. He was obliged to confess that when the idea of the Institution had been formulated by a group of gentlemen very soon after the war, he had no idea that he was to have the pleasure of being present at a function of this kind, and although he personally had very big ideas of what a production engineer should be, it had never once occurred to him to think of the young men. He admitted that this was his oversight, and that he had learned better. He had very great pleasure in seconding Mr. Hannay's motion, and added his best wishes for the Graduate Section in Birmingham.

The motion was put to the meeting, and carried unanimously, with applause.

The name of Mr. D. A. Tilt was proposed by the Chairman as the first Chairman of the new Section. This was seconded by Mr. A. K. Anderson (Graduate) and carried unanimously.

The Chairman further proposed that the following Committee, as provisionally adopted, be officially elected to serve for the following session : Messrs. A. K. Anderson, E. R. Baller, A. E. Groocock, A. McNab, D. A. Tilt, and G. A. Wood (Graduates) ; also R. H. Youngash, J. France (Hon. Secretary), W. Groocock and H. F. Spinks of the Senior Committee.

The proposal was seconded by Mr. V. L. Boland (Graduate), and carried unanimously.

The Chairman then proposed that Mr. G. A. Wood (Graduate), be the Hon. Secretary of the new Section.

Mr. E. R. Baller (Graduate), seconded the proposal, and it was carried unanimously.

The inauguration of the new Graduate Section having been completed, Mr. Hannay requested Mr. Tilt to take the chair for the ensuing meeting.

MR. TILT, on taking the chair, said that, as a new member, the honour of being the first Chairman of the new Section had come as a surprise to him. That Birmingham, and not London, had the honour of starting the first Graduate Section had been a second surprise, but in his opinion this was due to the fact that Birmingham members had been the mainstay of the Institution. There was not at present much difference in the numbers of the two Sections, but he looked forward to Birmingham being the biggest Section of the Institution in the future.

As first Chairman of the Graduate Section, he wished to take this opportunity of expressing the thanks of the Birmingham and Midland Graduates to the Members of the Council, who had allowed them to have something to say in the matter. The number of Graduates on the roll was twenty. This was not a large number, and he hoped to see it doubled during his year in office.

They had already arranged for the next session two lectures and two Informal Discussions, all of which were open to both Graduates and Senior Members. Visits to Works were also in view, but not yet decided upon. On the invitation of Mr. Field, they had, that afternoon, visited the works of Messrs. H. W. Ward & Co., and had enjoyed a very good time there. He then called on Dr. D. S. Anderson to give his address on "The Training of the Production Engineer."

THE TRAINING OF A PRODUCTION ENGINEER.

Paper presented at the Inaugural Meeting of the Birmingham Graduate Section,
by D. S. Anderson, Ph.D., B.Sc., M.I.Mech.E., M.I.A.E.

I BELIEVE that your Institution has made many attempts to define what is a production engineer but that so far you have been unsuccessful. Despite a failure on the part of your distinguished members to agree on this fundamental matter I am going to venture a definition. "A production engineer is one who produces or who assists in the production of a finished article from raw materials." The essence of the thing in my opinion is the transition from raw materials to a finished article. That brings within the scope of the definition all who produce finished articles from raw materials and not merely those engaged on mass production which is often too hastily assumed to be the only form of production engineering. The production of a single unit may be fraught with as many difficulties and problems as the production of 100,000 units.

I have endeavoured to give some sort of definition to the production engineer as, according as we envisage his duties and responsibilities, so we will plan his training which is the object of my address to-night.

There is no doubt that in this country we have for far too long neglected the specialised training required in this branch of engineering and might have continued to neglect it had the amazing developments in mass production of the last fifteen years not forced us to take stock of the situation.

Up to a few years ago two types of engineering course were offered in our technical colleges, one the National Certificate Course, the other a trade course. The National Certificate type of course is so well-known that it scarcely needs any explanation, but it might be worth while to give a little attention to it to consider the subject matter of its curriculum. The first three years of the course are of a general nature and include mathematics, machine drawing, mechanics, and elementary heat engines. The fourth and fifth years permit of specialisation, but as a rule no entirely new branch of engineering is taken. The subjects comprise mathematics, heat engines, strength of materials, theory of machines, hydraulics, and perhaps some metallurgy. There is no doubt the course is an excellent one and suits the needs of a number of students, particularly

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those who are likely to be engaged on the design side, but by no means all young engineers are likely to be engaged on this side and the course offers too little help for those whose job is not design by manufacture. The mathematics is carried up to and covers a moderately wide field in calculus, the heat engines involves a good deal of applied thermodynamics often treated mathematically, the strength of materials, theory of machines, and hydraulics all involve a large amount of special analytical treatment not of immediate value to those who chief interest is manufacture.

The only alternative to this type of course until a few years ago was a trade course dealing rather narrowly with one particular trade and not embracing the general problems of production.

The continuance of the National Certificate Course alone without serious alternatives despite the limitations of its appeal, has to a certain extent been due to the recognition awarded it by the Institution of Mechanical Engineers, whose own examination subjects and syllabuses follow similar lines. The feeling that there was a serious gap in our engineering courses had, however, been steadily growing and has resulted in the last few years in a type of course, not inferior in standard but quite different in its component subjects, being set up to cater for the needs of those engaged on the manufacturing as distinct from the design side. The intiative in setting up these courses has not all come from the technical colleges and I would like to pay a tribute to the very valuable work that your Institution has done and is doing on the question of education and training for production engineering. I have had the privilege of sitting on your Examination Board, and not being a member of the Institution I can praise whole-heartedly the valuable work of your representatives on that Board.

It is possible that our neglect of special courses for production engineers has been partly due to a misconception, a very serious misconception that mass production means the elimination of a very large proportion of skilled operatives and that therefore the need for technical training is diminishing. In my opinion nothing is further from the truth. As I envisage it the position is this. Modern industrial conditions demand not only a number of skilled and semi-skilled operatives but also a number of intermediaries between the operatives and the works' administration. Scientific organisation requires a detailed subdivision of work, a minute and careful preparation for all the operations, strict control of materials, strict supervision of all processes, and for these tasks men of proved technical competence are required, with ability to control and ability to adapt themselves to changing circumstances. The only men who can fill such posts satisfactorily are those who have had a sound training in mechanical practices, in the principles underlying those practices, in materials and their properties, and in methods of

organisation and control. In modern production there is no room for rule of thumb. Every effect must have a cause and people are required who have been trained to think clearly, argue logically, and by accurate analysis separate effect from cause. If that is accepted as a true picture of the present situation then the necessity for specialised training is already conceded.

What form should this training take? Well, what must a production engineer know? If we can decide what he should know, then we will be able to frame a course to provide that knowledge. I hazarded at the beginning of my remarks a definition of a production engineer as one who from raw materials produces a finished article. That definition, while it may not satisfy all of you is, I think, fairly near the mark and gives the key to the problem. *The production engineer is concerned primarily with the manipulation of materials.* It is around this that his course should be built, just as the National Certificate Course is built, roughly round the steam and internal combustion engine and their associated problems.

It may be taken for granted, I think, that the course of study should cover five years concurrent with the works' apprenticeship or period of training. We will no doubt find that this period is all too short for the many subjects which will be clamouring for a place in the course. Further, following the usual practice in other courses, this period of five years can be divided in a period of three years and a period of two. The first three years is usually called the Senior Course and the last two the Advanced Course. The Senior Course is devoted to general fundamental subjects, and special subjects appear in the Advanced Course.

Beginning with the fundamentals the production engineer must be able to calculate, must be able to draw and sketch and be able to read drawings quickly and accurately. He must have some knowledge of mechanics since machines are simply mechanisms for the transmission or transformation of forces and the various operations on materials all involve the application of forces operating usually in the plastic range of the material. Therefore, a good knowledge of mechanics is essential. Then there are the key subjects of Properties of Materials and Workshop Processes. These are fundamental, essential, subjects which should occupy the first three years. I do not propose to draw up a course in detail but rather to indicate the ground which I think should be covered in each subject, the grouping of the subjects will vary to a certain extent according to individual preference. I propose therefore to examine the subjects now in some detail.

Mathematics.

The principles employed in mathematics are of course universal, there is no particular brand of mathematics applicable to production engineering alone, but as all mathematical teaching must be illus-

trated by examples a careful choice of examples should be made choosing those which have a bearing on production engineering.

For example, a student must learn to calculate areas and volumes. Instead of choosing various imaginary figures and solids for this purpose the teacher should select materials and forms found in the workshop, sheet, round and hexagon bar, pipes, joists, etc. What most students lack in mathematics is manipulative skill. It is amazing how many will know that the area of a circle is πr^2, but how few will be able to find " r " for a given area. In developing this manipulative skill, examples can be chosen from the works, for example the interrelation of r.p.m., diameter, cutting speed, and weight of metal removed, pulley and belt speeds, gear trains, etc. In this way the student will appreciate the value and importance of the mathematical principles.

So also with trigonometry. This subject is most important and the production engineer should have a sound knowledge of trigonometrical ratios and the solution of triangles. Again, examples for teaching purposes should be selected as far as possible from works' practice and there is no lack of suitable examples to be drawn from marking off problems, jigs, and gauging.

A section of mathematics not usually included in an engineering course is that dealing with simple and compound interest, depreciation, sinking funds. I feel that this should not be omitted from a production engineering course as the question of depreciation, sinking funds, etc., is of the utmost importance in connection with replacement of machine plant and costing. One could conveniently include in the mathematics class the various systems of payment by result and their methods of calculation.

Some calculus should be included but not carried to an advanced stage. It is of importance in determining, say, economic batch sizes and other problems. In teaching calculus stress should be laid on graphical methods because of their great utility and wide application.

That I think covers the mathematics which the production engineer need know. It is not very extensive but he must be thoroughly familiar with it and be able to use it as a tool for the solution of his problems. He must possess a high degree of manipulative skill in his handling of it.

Drawing.

I do not think there will be much diversity of opinion on the need for drawing, though there may be some diversity on questions of detail. What should be kept in mind from the outset is that to the production engineer " drawing " is a language of a particularly concise and condensed kind. The sole function of a shop drawing is to convey information, it might well be called a three-dimensional

language. Drawings must first of all convey an accurate impression of form, secondly an accurate impression of dimensions, and thirdly there may be information required as to surface finish, limits of tolerance, etc. In order that a student may either prepare a drawing to give an accurate impression of form, or secure an accurate impression of form from the study of one, he must be able to think in three dimensions, that is he must have a good knowledge of solid geometry. I do not imply by this that an extensive course of formal solid geometry is required. A certain amount will be required but a very great deal can be taught incidentally in the drawing of machine details. I do feel, however, that this question of being able to think clearly and, to borrow the language simile once again, fluently in three dimensions is absolutely essential. One has only to think how often the production engineer has to visualise, when planning new developments, complicated machine tools, carrying out forming operations in three dimensions to realise at once that this is so. Having developed the ability to project correctly and having acquired a reasonable degree of neatness from simple exercises, students should then practise the preparation of drawings of details of varying degrees of complication complete as they would be issued to the shop. In this way they will learn what to look for in a shop drawing and where to look for it and incidentally will learn quite a lot on the subject of finishes, tolerances, materials used for different purposes, etc. It need scarcely be added that some instruction should be given on the subject of pictorial sketching.

Mechanics.

The branches of mechanics of importance to the production engineer are those dealing with force and motion. In the presentation of this subject experiment should play a large part for only in this way will the student acquire a real appreciation of the physical significance and practical application of the principles involved.

Students will readily grasp the idea of a force, such as a push, pull or twist. They must then appreciate the reactions which are set up when forces are brought into play and should learn to analyse the forces, couples, and reactions at work in a simple mechanism. Following on this should come resolution of forces not, as it usually is, limited to two dimensions, but extended to cover three dimensions. For example, the resolution into three dimensions is of importance when one comes to study the forces brought into play at the point of a cutting tool, or when one analyses the problem of lifting tackle.

Then there is the problem of the work done by a force or couple. There will be no difficulty in choice of examples from workshop practice. At this point stress might be laid on the interrelation of speed and force for the same work output as affecting the problem of cutting speeds and depth of cut.

Something should also be said about the input of work to a simple mechanism or machine as compared with the output from it and so develop the idea of machine efficiency. Friction and lubrication must also be mentioned but only lightly at this stage.

The laws of motion are of direct importance to the production engineer. He must know from varied experiments the way in which the velocity acquired under the action of a force depends on the time of application, the acting force, and the resisting mass. He must develop a real appreciation of inertia, and the forces brought into play when velocity varies. He must appreciate the nature and effects of impact and its application in the action of hammers and drop stamps.

These conceptions are not easy but a thorough grasp of them must be obtained as production engineering bristles with problems involving them all. They will best be acquired by the performance of carefully chosen simple laboratory experiments which can be linked up in principle with some workshop operation. In this way the student should be able to build up in the space of three years a fairly clear conception of these important principles of mechanics.

Properties of Materials and Workshop Processes.

This section of the work will be dealt with both by lecture and by practical work in the shop. It cannot be made too clear that the object of the shop work is not to develop manual skill but to enable the student, through specially selected experiments, to get a thorough grasp of the principles underlying workshop processes involving the cutting and deformation of metals. This is work which cannot be done in the factory where, of necessity, everything must be subservient to production, and the mere daily performance of workshop operations alone is not sufficient to reveal to the youth the principles behind what he is doing. What I mean is that a sound knowledge of workshop processes and the principles involved cannot just be "picked up" in the factory but requires careful and systematic teaching just as much as any other subject. It has been assumed for far too long that there was nothing in this work which could be taught whereas the truth is that it is just as suitable a subject of instruction as any other in the engineering curriculum.

I might now give some indication of the actual ground which I think should be covered in this subject in three years but I would like it to be quite clear that the order in which it would be desirable to give it in the class is not necessarily the same as the order in which I am giving it now. In discussing a syllabus covering more than one year it is convenient to consider in turn all that would be given under each section rather than split it up into the portions that would be given each year, as this would best be left to some extent to the choice of the teacher.

In the first place the production engineer is in general concerned chiefly, if not solely, with constructions in metals. Metals are taken in various standard forms, ingots, bars, sheets, etc., and various primary forming processes and machining operations are applied to these to form the finished article. Instruction will therefore be required in the composition and properties of the principal ferrous and non-ferrous metals. Their density, strength, hardness, ductility, toughness, etc., are all important and the effect upon these properties of temperature and of hot and cold working must be studied. This will include the more usual processes of heat-treatment such as annealing, normalising, quenching, tempering, etc. Concurrently with this lecture work there should be shop experiments illustrative of the various processes. There will be no lack of suitable examples, indeed the difficulty will be to make the necessary choice. In the early stages the shop experiments should be kept as simple as possible, adopting those which do not require anything beyond the ordinary workshop equipment. When this ground has been covered the student will be able to grasp why certain materials can only be used in certain ways and how the properties of those materials modify the manufacturing processes to which they can be satisfactorily subjected. One would naturally then be led on to discuss the various primary forming processes such as casting, drop stamping, pressing, and drawing, and fabrication by welding. Most of this work would be covered in the first two years and in the third year a little physical metallurgy might be introduced, dealing with the simpler aspects of microstructure and the relation between microstructure and properties. Standard tests for tensile, bending, hardness should be carried out by the student. This is a rough outline of what might be covered on the subject of metals, their properties, and the primary forming processes to which they are subjected.

The next important section of the work is that of machine tools and machining. The student will require some instruction in the principles embodied in the design and construction of the centre lathe, drilling machines, planing and shaping machines, milling machines, capstan and turret lathes. In all cases methods of setting up and holding work should be explained and illustrated in the shop. In particular stress should be laid on the conditions necessary for the production of accurate work, on the care of the machines and their correct adjustment, on the importance of rigidity in the holding of the work and tools. The whole of this is a big subject and all that could be attempted would be a general survey of the field with a particular examination of the simpler examples. Any treatment of the more difficult and complicated tool-settings would have to be deferred to an advanced course.

Some elementary consideration would have to be given to the

subject of speeds and feeds as affecting power absorbed, temperature of tool tip and finish of work. This would lead on to the very big subject of cutting tools. It is very doubtful if there would be time in the first three years to go deeply into this subject but certain aspects of it would have to be dealt with. Only the simpler tools for the lathe, planer, and shaper should, I think, be considered in respect to clearance, rake, cutting angles, tool profile, etc. Then there is the question of grinding and the precautions to be taken to maintain accuracy and prevent damage. One could not very well omit the subject of drills, reamers, milling cutters, and screw-cutting tools, taps, and dies, but there would not be time to deal with this in much detail. As has already been said, the subject of cutting tools is a very big one and the most careful selection would have to be made of those sections of it suitable for inclusion in the first three years of a production engineering course.

The shop work in connection with cutting tools will consist chiefly of measurements of power absorbed with different feeds and speeds, the effect of speeds and feeds on surface finish, the making of tools from high carbon steels and special alloy steels and the experimental investigation of simple problems in cutting angles.

A few sections still remain to be dealt with. Some consideration should be given to standard auxiliary equipment such as chucks, machine vices, circular tables, and dividing heads. These will be treated descriptively and their use illustrated in the shops.

At this stage the subject of lubricants and coolants need only be touched on lightly. Their effect in keeping down the temperature of work and tool and their effect on finish of work are the important aspects.

Something should be said about grinding, wet and dry, about the different types of wheel, grit, grade, and bending. Instructions will be needed on the choice of wheel for the work to be done, mounting and balancing of wheels.

Measurement and gauging will to some extent have been treated in the mathematics class, but more particular attention will have to be paid to the workshop measuring instruments, the vernier, micrometer, vernier caliper, dial gauge, and sine bar. With regard to gauging, too great stress cannot be laid on the care of gauges. The use of "go" and "not go," length, depth, wire, plug, and gap gauges should be explained, together with tests for roundness, truth, and concentricity. An excellent shop exercise would be the construction of a gauge for some special measurement, for in no better way can the great difficulties associated with really accurate measurements be appreciated.

Finally it is essential that some instruction on safety measures be given and the vital need stressed for the active co-operation in safety work of all engaged in production.

That, I think, covers the ground of what could reasonably be expected in a three-year senior course. When it is all put down on paper it makes a formidable total, but with skill and judgment on the part of the teacher I think it could be successfully covered by the average student.

Advanced Course.

While I have fairly clear ideas of what should be the content of the first three years of the course, I confess to somewhat less definite notions regarding the advanced years, the fourth and fifth. In no part of the country have production engineering courses been running sufficiently long to gain any experience with the fourth and fifth years, and any suggestions I put forward are therefore tentative. For the next few years the numbers in advanced courses all over the country will be small, and it will not be possible therefore to offer alternatives ; only one group of subjects will be offered in each year, but looking further ahead, say in the next 5-10 years, I am certain our production engineering courses will then have sufficient numbers to justify some degree of specialisation on the part of the students. Certain subjects would be essential, such as Organisation and Management, Jig and Tool Design, and some additional work on Workshop Processes. Outside those three there are a number of others, all of which might reasonably form part of an advanced course. Progress and Planning, further work on Physical Metallurgy, and Materials Testing, Foundry Work, Electrical Engineering, Costing, Estimating and Accounting, Economics, and doubtless there are others of value for particular local needs. Perhaps I might just touch very briefly on each one of these, giving an indication of what might be included under the various headings.

Organisation and Management.

This is a very big subject and a judicious selection must be made from all the possible material which might come under this heading, On the whole, only the broader aspects need be dealt with under this heading, as many of the more detailed ones appear elsewhere in the course under different headings. The treatment might include general staff organisation and the duties of the various members of the staff, relation of drawing office with shops and shops with one another ; selection of a site for a works, factors to be borne in mind, railway facilities, wharfage, etc. ; general lay-out of works and lay-out of individual shops, modern methods of shop lighting and heating ; general equipment of workshop, standardisation within the factory ; principles of production, different methods of organising for mass production ; charting as an aid to management ; general principles of costing and estimating, depreciation ; various systems

of payment by results ; stores organisation. These, I think, are the broad problems coming under this heading which are of prime importance to the production engineer.

Jig and Tool Design.

This is one of the most important subjects in the advanced courses. The syllabus should cover the design of jigs for various types of machine tools and operations, the method of holding and locating the work, problems of distortion through clamping forces and through the relief of stress as a result of machining, checking the accuracy of jigs and fixtures, rapid loading jigs for quantity production. On the tool design side the principal problems to consider would be the tool lay-outs for capstans and automatics and the design of press tools for blanking, raising, and drawing.

Workshop Processes.

One part of the work coming under this section would comprise the more difficult machine shop operations, the cutting of special accurate screw threads ; spiral milling and thread milling ; gears, the elements of gear teeth, gear-cutting by forming and by generating, various special gear-cutting machines, gear grinding. In connection with all these there will be the associated problems of cutting tools, speeds and feeds and suitable workshop experiments should form part of the course.

It is probable that press tools will have been touched on only lightly in the senior course and some further consideration is due here of the more difficult problems arising in manufacture by pressing.

More advanced work on gauging and measurements will come into this section, gauging of screw threads for pitch, diameter and form, by measurement and projection, gauging of gear teeth, Johansen slips, gauging tapers, dovetails, and special forms.

That covers the three subjects which I think might be considered essential in the advanced course and with these can be combined any of the optional subjects which I have already indicated, Progress and Planning, Physical Metallurgy and Materials Testing, Foundry Work, Electrical Engineering, and Economics. Additional Mathematics and Mechanics could also be taken if desired.

Progress and Planning would deal with much that could not be included in the broad survey given under Organisation and Management. For example, it would differentiate between piece, batch, and quantity production and deal with the relative advantages of group and line production. The division of machining into operations and the factors governing the first or datum operations would come into this section as would also the question of roughing and finishing operations with intermediate heat treatment to remove internal stresses. There is also the question of removal of distortion

occurring during machining and the effect of this on the sequence of operations. Inspection, progress work, route cards, control methods. charting, conveyors and mechanical handling for work in progress, stores and store systems would be dealt with here.

Many students, I imagine, would find the amount of physical metallurgy and testing of materials obtained in the senior course to be inadequate for their needs, and would welcome an opportunity for additional instruction in this subject. Hot pressing and extruding, for example, two very important processes, are dependent on the plastic properties of the material at high temperature. Physical metallurgy in an advanced course might well deal, amongst other things, with properties of metals and alloys at elevated temperatures. With the aid of a testing machine and a metal working press a great deal can be learned in this way. *It must never be forgotten that, while the designer is primarily interested in the elastic properties of materials, the production engineer is interested in their plastic properties. Every single operation which he carries out is carried out beyond the elastic limit of the material.* He is therefore interested in metals and alloys which will deform without serious alteration in their properties. I suggest that a fair amount of time in this class in physical metallurgy should be devoted to the preparation of ranges of commercial alloys and an investigation of their plastic properties with the testing machine, the press, the rolling mill, and the draw bench. Such physical properties as are found should, of course, be correlated with the structure as determined by the microscope. There will also be much work to do on heat treatment and on special tests such as the Vickers Diamond Hardness test, the Erichson test, impact tests, and others.

In the first three years of the course there will not be much time to devote to foundry work. Some elementary experiments in the way of casting may be done in the shop, but no detailed consideration will have been given to the subject. It may be that some students will wish to specialise in foundry work, or at least to increase their knowledge of that important branch. A class extending over one session may well be devoted to it. The lecture work should be supplemented with a considerable amount of experimental work. For this purpose it is not necessary to have a completely equipped foundry. A great deal can be done with simple equipment, since the production engineer is interested primarily not in moulding but in the properties, particularly the machinability, of cast metals. The instruction should cover the cupola and the range of commercial irons used, together with the special irons containing nickel, molybdenum, etc. Then there would be the range of non-ferrous alloys, the copper-zinc, copper-tin, copper-aluminium, aluminium-copper. All these could be prepared and their physical properties and machinability examined. Some instruction would be required on moulding sands,

and methods of moulding, particularly with regard to machine moulding. The organisation of a foundry for continuous production would be of importance and would include, in addition to the actual moulding and casting, problems of handling, distribution, and conveying of the material. I feel certain that such a class would be of great value to the production engineer, as it is almost certain that the successful student will one day find a foundry, as part of a works, under his control.

Electrical Engineering I will only just touch on. Here what is wanted is something quite different from that usually taught to electrical or even mechanical engineers. The production engineer is interested in the characteristics and performance of motors and their suitability for different machine tool drives. He is interested in electric furnaces for heat treatment, in electric furnaces for melting, in illumination and in many other electrical problems. What is required is a special composite course embracing all these. Such a course does not exist at present, but could be readily developed to meet a demand.

Costing, Estimating, and Accounting will be valuable sections for those aiming at taking up the commercial side.

The last optional subject I put down was Economics. There is a fashion at the present time to push economics into every possible course. I think it is to be deprecated. Admittedly it is valuable, but in my opinion there are other more valuable subjects.

That completes my survey of the training of a production engineer. Much of it is tentative, as we have not yet built up a body of experience to guide us, but I think the solution is to be found along the lines I have indicated.

Discussion.

MR. D. A. TILT, Grad. I.P.E. (Chairman), said that Dr. Anderson might be included in the first rank as a production engineer, because as he had mentioned in his address, " A production engineer is the man who takes hold of the raw material and turns it into the finished article." If graduates did not object to being called " raw material," at an early date they might become the finished article. Dr. Anderson's theory as to what a production engineer was, would at any rate give scope for argument amongst the senior members.

MR. WITHEFORD congratulated Dr. Anderson on his most excellent paper. Admittedly his time had been short, but his choice of subjects had been well explained in that time. The production engineer was in direct contact with the men in the works, and upon him fell the very great brunt of the administration. The time had now come when we must regard the point of view of the workmen, and in this connection he would mention the example of Henry Ford. Whilst carrying out an extensive research among the workfolk in his factories to determine how waste of effort might be minimised, the great motor magnate was surprised to find that the men whom he was attempting to assist with scientific investigation were most antagonistic to the schemes, suggesting that this was an attempt to get more work out of them than they could give, an impression which was entirely erroneous. We must look to the production engineer to overcome this prejudice, and he must therefore have a thorough knowledge of men and be able to show them that his methods bring mutual benefit. It is necessary for the successful engineer to instil within those around him the knowledge that the obtaining of profits, and profits alone, at the expense of the men, is not his aim, but service—service in the true sense of the word, dedication of his ability to the common good.

It seemed to him that in the course outlined by Dr. Anderson an alternative subject should be Psychology—the study of the men themselves. Out of the knowledge acquired during his investigation of this subject, the production engineer would be in a position to bring home to the men the fact that in mutual service and co-operation lies the greatest benefit to everyone. Had not the time arrived when flesh and blood should be considered in this great industrial system ?

MR. J. D. SCAIFE (Member of Council) said they had had a good start in the first speaker, who had touched on the point of psychology, which he himself had been going to mention. There was one point he might mention, without going into details about Dr. Anderson's address, and that was the distance the Institution had moved, when

it could bring forward such a man as Dr. Anderson, giving the views he had expressed that evening. Such a thing was not possible before the war. If they could spread the gospel to all technical institutions throughout the country, they would have done a very great work, because there was nothing like starting with the young in doing anything.

He did not want to deprecate anything Dr. Anderson had said with regard to technical education, but everybody had their own views. Many of them had had a fair measure of success in their profession, and probably each of them would have a different opinion on what was a successful production engineer, and different ideas on training. Personally he had been over the whole ground, of mathematics, machine drawing, and metallurgy in his education as a production engineer, but he had found little of what he had learned to be of use at the present time. When he had a mathematical problem, he put it into the drawing office, and did not bother with it. He had never had time. He would not say that one ought not to learn it, but he wanted to make the point that while there was a certain amount of knowledge to be acquired in order to be a successful executive in a production organisation, there were certain things which were more outstanding than the actual knowledge acquired. An old teacher of his, who knew nothing about engineering, and said so, claimed that he had at least taught him to think.

A man could not go through the syllabus Dr. Anderson had outlined in his lifetime. Even if he started now and studied until he was fifty or sixty years of age, he could not learn it. Many of those things, gear grinding and things of that sort, were in the specialist's department. If a man was going to be a specialist in gear grinding, manufacture of machine tools or motor cars, many of those things would have to be left to a later date, when he would specialise, but the most important thing was for the man to learn to think—to learn to find the essentials out of a mass of inessentials. If one learnt that, a great deal had been done.

Referring again to the matter of psychology, a man had to be something of a psychologist, and if he were not able to assess the value of the various people under him, he could not be a success, however much technical knowledge he had acquired. It was essential to be able to judge the character and integrity, as well as the technical ability, of his people.

Another thing was, a man could not be a good production engineer unless he was a sportsman. He must see that his people were given a square deal. His word must be his bond in dealing with labour. That was the most important thing a production engineer could have in his mind.

Coming to the technical side, a production engineer at the present time must have a knowledge of metallurgy, and he thought that, if

we lacked anything in this country, it was a knowledge of metallurgy amongst production engineers. Before the war practically nothing had been known about high tensile steels. Very few steel manufacturers made them. They had known about mild steel, brass, cast iron and certain of the main metals, but very little about nickel-chrome steels, and about heat treatment. There were very few heat treatment departments ; most of the heat treatment before the war had been done in the smithy fire ! Metallurgy was a subject which ought to be included in the knowledge of the production engineer, and, apart from that, the ability to add up, subtract, and multiply and divide—simple arithmetic. The production engineer did not need much more than that, because nowadays they had specialists to deal with those things. However, for all that, the early training had to be gone through as a matter of discipline, because a man could not be a master except he had learnt to be a good servant, and he must have gone through that period of doing things he did not like to do. We all did things well that we liked, but the main weakness of human nature was that we hated to do things we did not like.

Mr. Holman (Graduate) said he had been greatly interested in Dr. Anderson's address, more particularly because he had been one of the first students to take the production course. He had often heard it mentioned at the senior meetings that, in these days, the cost accountant should be in close touch with the production engineer. He would therefore like to ask Dr. Anderson if he did not consider the time had arrived for a certain amount of fundamental knowledge of cost accounting, as applied to factory plant, to be included in the syllabus ? This might include the allocation of on-costs and the distribution of overhead charges.

Mr. V. C. Allix (Associate Member), spoke on the subject of the value of sketching to production engineers. So far as the production engineer was concerned, in his opinion, it was a very valuable asset to be able to sketch correctly and quickly. It was the quickest means of conveying an idea either to workpeole or anyone else. He suggested that, when taking a course in production engineering at a college, it would be very useful if every student made a point of trying to sketch as many things as possible connected with the problems given to him ; in making a graph, he could try to put in the curve freehand, and hence eliminate using such a thing as a French Curve. Valuable time was lost in the final examinations by students who made elaborate drawings instead of a simple freehand sketch. The use of well-proportioned sketching, also, might be the means of saving several hours of work in the drawing office.

Mr. R. H. Youngash (President, Birmingham Section) expressed his personal pleasure in Dr. Anderson's presence at the Inauguaral Meeting of the Graduates' Section, and endorsed the remarks Mr. Hannay had made that they were making history. He hoped to see

Graduate Sections started in most of the local Sections ; probably they would ; but those present would always remember the happy occasion when the first Graduate Section was started, and that Birmingham was the proud parent of it.

He had listened with great interest to Dr. Anderson's address, and did not propose to cross swords with him, or even question whether the syllabus could be assimilated in fifty, or sixty years, which Mr. Scaife had doubted, but he emphasised a point in Dr. Anderson's address, that no student could acquire too much information on any of the subjects he had mentioned. Obviously that must be so, because the student did not know what direction his activities were going to take. If he knew he was going to make motor cars, stampings or castings, then he might specialise in some particular direction which would be of greater assistance than in others, but he must be prepared for what life had to offer him, and therefore he could not possibly acquire too much knowledge. There were a certain number of men who had made not only a good living, but a reputation by being opportunists ; by finding out, when a problem was put up to them, exactly what everyone else had done, making some other suggestions, and, in the vernacular, " getting away with it." This could not happen to everyone, so that the better the student was prepared for dealing with anything unusual, then obviously the better was his chance of handling it.

Another point he would emphasise was " Do not be square pegs in round holes." If they were of a mechanical turn of mind, and he believed that engineers, like poets, were born and not made, they should find out the particular branch which was most interesting to them and get into it. They should get into it while they were young, and stick to it, and they would find that, instead of being sorry they had to work from six o'clock and then go to night school, as Mr. Scaife had said, they would be glad to work through the normal hours and go back in the evening and work overtime, for recreation !

A further point he would make was, " Do not take anything for granted." This was where the value of previous training came in. In this connection he quoted the instance of a young fellow who having a considerable amount of elementary knowledge such as a schoolboy would have, was put in to the stores. After being there for a few days, he was asked for a " half-inch tap," to which he replied obligingly that he was sorry they hadn't got a half-inch tap, but would two quarter-inch do ?

Bearing these elementary matters in mind, they would realise the importance of having a thorough knowledge of the subjects with which it was anticipated they would have to deal, and if they bore in mind also that when they had finished their technical education they were just starting, he was sure that the Graduates trained in Birmingham, under the syllabus drawn up by men like Dr. Anderson, Mr. Dodds,

whom he was pleased to see with them, and members of their own Institution, would be able to take their places in the front ranks of production engineers, and he wished them all the very best success in that direction.

A GRADUATE, said he was not a production engineer, but a Draughtsman, and had "got away with it" so far. Having read Dr. Anderson's Synopsis, he felt convinced he must know everything that a production engineer had to know as well. In other words, to know sufficient to be a draughtsman did not now seem enough. The draughtsman should have a very close connection with the production engineer. He was inclined to agree with Mr. Scaife, that a lifetime seemed a very short time in which to get such intensive knowledge as had been outlined for the draughtsman, designer, and production engineer. Mr. Scaife had also mentioned that when he got a mathematical problem, he gave it to the drawing office, and perhaps the drawing office were only too glad to do it for him! The speaker thought the production engineer might pay a little better attention to the drawing office. His experience had been necessarily short, but it seemed to him that a great deal of attention was paid to methods of manufacture when a part was in the shop. When the part had been designed, and its material decided, then the production engineer got busy and determined how it should be made, and did not seem to pay a great deal of attention to the drawing office in the way of changing material, where it might be beneficial. Of course, that was up to the drawing office, hence the statement that the draughtsman was much of a production engineer. We could not, however, do everything, and in these days of specialisation, there ought to be closer alliance between the designer and production engineer. It was not enough for the production engineer to be *au fait* with the men in the shops, their methods of work and character; let him also study when variations and corrections might be advisable. A little bit more time spent in the drawing office and a little bit more time and energy spent in advising the drawing office in the matter of design and choice of materials, would be amply repaid.

MR. A. K. ANDERSON (Graduate) said he had been a production engineer for several years, and had found that, as a production engineer, he was expected to do a little bit of everything in every part of the works, whether it was directly connected with actual production or not. One of the items which he had found of importance, and which received very little attention, had been the connection with the drawing office. Whilst the executives or chief draughtsmen were all right, the detailing would be left to youngsters, and the drawings which went down into the works were often far from complete. Perhaps one dimension would be put down twice, and another, which was badly wanted, not down at all. It seemed

that more co-operation was needed between drawing office and works. Presumably it was the production engineer's job to bring about that co-operation. Amongst other jobs which fell to the production engineer was that of not merely taking an article when it was designed and ready to go into the shops, but taking it when it was in process of design. Very often an alteration might be made which would cheapen that component, so that it was desirable that the production engineer should be called in during the process of designing, and therefore have some say in it.

Another item which he had found of considerable importance was plant lay-out. He did not think Dr. Anderson had touched this point, but it was one of considerable importance to the production engineer. In some cases plant lay-out and disposal was one of the primary difficulties to be got over, as in the instance of steel furniture, which took up a considerable amount of room. He asked Dr. Anderson to what extent he would include the question of operator's fatigue, and atmospheric conditions in the shop, and to what extent these came under the production engineer ?

Mr. V. L. Boland (Graduate), having referred to the interest of Dr. Anderson's paper to both past and present students of the Birmingham Central Technical College, said that the subject of specialisation was a very difficult one for some of them. Some speakers had urged this, whilst others had emphasised the need to know everything one could.

The first speaker had mentioned psychology, and no doubt this was one of the biggest factors in a business man's career. From his experience, men in executive positions, i.e., general managers, etc., could not be called expert in any one thing, due to their non-specialisation, but one thing they could do was to sum up and choose men of the expert class to fill key positions whose decisions they could rely on. As regards the National Certificate Course, the popularity of which Dr. Anderson had commented upon, " popular " was rather a misnomer, in so far as there was no alternative—it was a case of having to take it. There was also a great number of technical college teachers to-day who knew a great deal about production, but who were not up-to-date because certain manufacturers would not grant facilities to visit their works from time to time. There was, too, in their city a great lack of opportunity for getting really good information on subjects which were developed outside this country. The production engineer must be up-to-date, and there was no doubt that the Americans, Germans and other continentals had good books on certain subjects which we had not. He mentioned his experience, in his own city, of being able to go to a Carnegie Trust, and order any book, whether American, German or any other kind, and that book would be obtainable and could be had on loan. That was a wonderful advantage.

MR. STEERS asked if there was any connection between technical college and works? Apprentices came to the works to be trained as mechanical engineers, and possibly, advised by the technical college, were led away from that and decided to become production engineers. The course was altered at school, in such cases, but did the works realise that the course had been altered, and would they give facilities for the apprentice, who had left the mechanical side to go on to the production side of the business, to take a particular course that would be of use to him? For instance, a period in the jig and tool drawing office and efficiency departments would be of greater use to a production engineer than a period of engine testing, where he could learn the faults of engines, which was absolutely on the mechanical side. With regard to the question of specialisation, and that of learning all one possibly could, he remembered an old engineer remarking that in a few years' time the foremen in a shop would require the knowledge that a superintendent had at the present time, and he thought this was absolutely true. The standard required of foremen and superintendents was obviously on the up-rise, and it was up to every engineer to learn as much as ever he could.

DR. ANDERSON, in replying to the various speakers, said that several of them had brought up the subject of psychology, as he had anticipated. Undoubtedly it was an extremely important subject, but it was a subject which was very difficult to teach. Take, for example, the subject of tact, which was one of the first essentials. It was very difficult to teach anything like that! Certain principles of psychology, possibly, could be taught, but it should be remembered that there were only three nights a week for five years, and they had to choose what could be done in the time. If something new was brought in, something else had to go out. It was a question of striking a happy balance.

Mr. Scaife had paid him a very nice compliment when he suggested that the academic mind had moved a little in the last fifty years. He knew that academic minds moved very slowly. Perhaps the exception in his case was due to the fact that he also had worked from six in the morning to half-past five at night, and in the evening attended classes, and so knew the problem first-hand.

He entirely disagreed with Mr. Scaife when he said that almost the whole use of training was to teach the student to think. He did not think that was true at all. Undoubtedly it did teach one to think, but at the same time, one acquired a tremendous amount of knowledge which was extremely useful. He would put it to Mr. Scaife this way: Mr. Scaife would not like to admit if he came and taught in some of their evening classes, that at the end of two or three years he would not have taught those people anything at all about production engineering, and would have taught them only to think!

Surely, he would like to claim that in addition he had imparted a quantity of very useful knowledge !

One speaker had mentioned the necessity of costing systems and accounting, and undoubtedly this was extremely important. It was an omission on his part that he had not included it. That should perhaps be included as one of the optional subjects. Some students might wish to choose it, and it would certainly be valuable.

Another speaker had stressed the importance of sketching. Undoubtedly this was so, and many formal drawings were made which could well be dispensed with, and sketches used in their place.

He was grateful to Mr. Youngash for supporting general training, which academic people stressed, and deprecating too early specialisation. He had often told students that in the five years they spent at college, they were getting the only training they were going to get for life, and therefore that training must be as broad as possible. The line in which they found themselves at nineteen or twenty, was not necessarily the line they would be in at twenty-seven or twenty-eight, and therefore the training must be broad. It was essential to bring in subjects which might not be of much immediate use.

Two speakers had rather cancelled each other out. The first had said he was a draughtsman, and that the production engineer ought to consult him more. The next speaker had said he did not know why the draughtsman did not consult the production engineer more. Evidently the first had only to ask and he would receive !

Mr. Anderson had said that plant lay-out had been omitted, but he pointed out he had mentioned it under the heading of Organization and Management. The same speaker had raised the very important point of fatigue and its relation to operating conditions. Undoubtedly some instruction on that should be included.

Another speaker had mentioned the matter of teachers being out-of-date. It was extremely difficult for technical college teachers to keep up-to-date. Once they got into the technical colleges, they became entirely immersed in teaching, and unless they got back into works from time to time, it was very hard for them to keep up-to-date. One had only to consider the present rate of progress to see that.

The last speaker had asked if there was any co-operation between works and college, and suggested that the student in the works did not always get put in the department which might best suit the training he was getting at the college. All he could say on that was that they sent their programme, and various pamphlets, to works, and also individual reports about students. Whether they were read, or put in the waste paper basket, or stored away in dusty files, he did not know, but the colleges did at least supply the information, and hoped it was put to the purpose for which it was intended.

MR. A. E. GROOCOCK (Graduate) proposed a vote of thanks to Dr. Anderson, who, he said, had lightened up a lot of dark places to them. What he had said about the educational side of the production engineer would lead those Graduates present to pay a great deal more attention to that side than they had hitherto done.

MR. A. McNAB (Graduate), in seconding the vote of thanks to Dr. Anderson for his address, commented on the number of new faces at the meeting. He expressed the hope that this good attendance would be kept up, and that all their lectures would prove as interesting as the one they had just heard. Although he had just completed a course at a technical college, Mr. McNab remarked, in the light of what Dr. Anderson had said, he felt he would like to start another course ! A syllabus had been put before them which was really far greater in its scope of subjects than they had five years ago. Graduates to-day had even better opportunities than before, and the syllabus to-day was far better and more useful than it had been a few years ago.

When at the technical college, he had wanted to specialise on something which nobody else had done. He had approached a member of the staff and suggested that he should carry this out, and for six weeks had toiled. Then he found that the necessary information was not available ; that he was on his own all the time ; and that there was not the necessary equipment to carry out his investigations.

He would venture to suggest to Dr. Anderson that he should obtain a little more modern plant, or whatever was needed to further students' progress when they had gone through the series of courses which brought them to what Mr. Scaife had described as " the thinking stage."

Mr. Scaife had said also that they could not possibly assimilate everything, even in sixty years, and Mr. McNab confessed that much of what he had learnt in the technical college, he had forgotten now. When, however, a subject did arise, he found that it did not take long to grasp it. As an instance, he had had a course in metallurgy—and had forgotten it. It was too big a subject to be taken in in three years ; it was a specialist's job, but he could talk about it, with a certain amount of reservation, as a Graduate should, and could express himself, and if anybody was talking about it he could understand them and could give, he hoped, a reasonable answer.

Dr. Anderson had said that the opportunity that was going to be placed before the Graduate of to-day was very large, and it had got to be grasped. If the student got hold of it ; even if he afterwards forgot it ; if he had been through it once, it would be there in his mind, and when he wanted it somehow it would come up.

DR. ANDERSON, in responding to the vote of thanks, said it had

given him very great pleasure to be there. Facing so many of his old students, he had felt rather like Daniel in the den of lions, but he seemed to have escaped without serious injury.

People generally underestimated the extent to which they used knowledge which they had acquired. They imagined that they had forgotten it ; that they had learnt a great deal and did not use it ; but once they had acquired it, it slipped into automatic use. It altered their attitude of mind, their outlook, and they used it in business in ways of which they were not conscious.

Mr. McNab had said he had taken a course of metallurgy, and had not gone very far. There was not time to go very far in a part-time course, but it did give one an appreciation of the work of the metallurgist which one would not otherwise have.

Mr. Scaife, referring to his remarks about " the thinking stage," which had been commented on by one or two speakers said that he had perhaps been misunderstood. He would emphasise the point that it was the duty of the teacher to keep his students always students. We were always learning, and if the student acquired the ability to go on learning, the teacher had done a great thing.

WHAT ARE THE FUNCTIONS OF A PLANNING DEPARTMENT ?

Informal Discussion, Birmingham Section.

THE Section President (MR. R. H. YOUNGASH), in asking Mr. Satchell to open the Discussion, remarked that although some of the members might be inclined to say " Why do we want a planning department," it would be noticed that the title was such that there was no necessity to debate that. They were there to decide what the functions were. They might ask themselves, is the idea practicable for a planning department to exist as a separate section ; is it the section of an organisation behind, but operating parallel with, a production department ? Then they might say, what should be planned in a department of this sort ; should their efforts be confined to plant and machinery, or should they include material, progress, and such matters as delivery dates ?

Is it possible to make a fixed plan, which, like the laws of the Medes and Persians, is immutable, or must the planning department be flexible, and vary according to conditions ? It might be said that, just as manufacturing and manual operations had been sub-divided, it would be found ultimately necessary to sub-divide the functions of management in exactly the same way, so that there would be not only a planning department, but other such departments, in sufficiently large works.

MR. H. S. SATCHELL : The term Planning denotes predetermination of future achievement, which, after acceptance of definite known factors, applies a methodical procedure in place of the haphazard or rule-of-thumb. Planning, in its broadest sense is the application of the simple idea of *thinking* before *acting* to the methods and routine of an organisation engaged in producing serviceable articles.

Planning Department.—The planning department is the vital link between the designing and manufacturing departments. The designing department says *what* shall be manufactured in the form of the product, and the planning department prescribes *how*, *when*, and *where* the product shall be manufactured. The planning department takes the design and scrutinises it for manufacture, frequently suggesting changes in detail whereby manufacture will be simplified without detriment to the final result. For this purpose the department comprises a personnel of specialists who are responsible for

following and putting into effect the most modern practices, and are available for advice and action beyond the scope of the manufacturing personnel, who are primarily interested in production.

The planning department co-operates with the estimating department in the closest possible manner. It directly controls all new lines of manufacture, preparing plans prior to completion of the estimate. It then follows these plans to conclusion, and hands over to the manufacturing department a unit capable of producing according to *plan*.

Presentation of Plan.—All managers agree that the preparation of a plan must precede manufacture, but it is not in all factories that the methods employed yield satisfactory results.

Some believe that the "direct way" is the best and cheapest, and, as a consequence, *simplicity of manufacture* is adversely affected because management is more concerned with simplicity of organisation. The latter often means lack of organisation, for the term *system* throws up the bogey of overhead expenses. The main object therefore, is to keep these at a low figure in comparison with direct labour costs. So long as the establishment charge is low, it is taken for granted that the factory is working efficiently, and yet many of these firms are struggling to make ends meet due to scarcity of orders. In other words, if " A " equals direct labour and " B " equals indirect expense, it is frequently overlooked that the factory cost is controlled by the summation of " A " plus " B " rather than by the Establishment Charge ratio $\frac{B}{A}$. These firms frequently then resort to price cutting as the only means of retrieving the position, and always, of course, without success ; granted that the manufacturing costs are high, but price cutting will never improve matters. Costs are high because the methods of *presenting* the job are wrong, and the solution is to present the job properly before fixing the prices, which must, and always can be, fair and equitable. Correct presentation, which is merely another name for planning, involves :—

(1) Accurate *timing* of all phases of manufacture.
(2) Careful *operation planning* or " job layout," which forms the basis of all manufacture.
(3) Good *factory layout* to avoid excessive handling.
(4) Careful *material planning* or *stock control* to ensure that material meets the planned dates with minimum tie-up in inventory.

Followed by :—

(5) Active *progressing* to ensure that the planned dates are accurately met.

We are this evening interested in the first three items, as the main

functions of a planning department, so let us examine each more closely.

(1) TIMING.—The *delivery date* promised to our customer is a definite obligation of the same order of importance as our obligation to invoice the apparatus, after dispatch, at an agreed price. This obligation can only be met with certainty if the many details of manufacture are scientifically allocated time objectives, based on the delivery date. It is then absolutely essential that these required *time* objectives are clearly placed before each member of the team responsible for its achievement. The tool for doing this is the *time chart*, which details the starting and finishing dates allowed for design and manufacture of the major and limiting components, so that by living to these dates, the final result in respect of *time* will definitely be achieved.

All members of the organisation must fully appreciate their responsibility, as laid down on the time chart. They must remember that all times are scientifically divided, and agreed, and consequently, without shortening deliveries, it will usually be difficult to make up for one lost day.

In the case of large and so-called special apparatus, the time allowances are based on :—

(1) Previous experience of manufacture.
(2) Knowledge of delivery dates for special materials from outside.

By dividing the complete apparatus into its many components, which can usually be divided into simple items, the times for manufacture of details, sub-assembly, and final assembly can be quite accurately assessed.

All times have, of course, been first determined from the actual times of individual operations, plus allowances for intermediate moves. This is the foundation of the planner's experience, and has become almost a timing instinct. We must, however, never forget this fact, for in work of an entirely new character, the only basis of timing must be the actual allowance in the *operation plan*. This brings me to the next step in production planning, which, although placed second in this paper for convenience, must always be first in successful practice.

(2) OPERATION PLAN OR JOB LAYOUT.—Operation planning is the heart of production planning, for it prescribes *how* and *where* the work shall be performed. To be entirely successful the *operation plan* should precede the *estimate of cost* on which the price to customer is fixed, and which must be met or beaten if our company is to make profits. It will readily be understood, however, that in an organisation handling a large number of different products, time does not permit always to prepare designs, drawings, and hence operation plans prior to quoting price to customer. Furthermore, such a

procedure would involve immense wastage of human effort, as all quotations do not produce firm orders. Consequently, operation plans can only be drawn up *prior to estimating* on new lines of business which promise large quantities, and for which the lowest possible cost is essential if the market is to be captured. Otherwise, the operation plans are made *after* receipt of the order, and to match each detail drawing as it is received from the design section.

The *layout* of the job is a complex proceeding which has for its object simplicity of manufacture. In all but a few instances, craftsmanship has given way to specialisation, which means the utilisation of the smallest amount of man-power for the highest amount of production. Methodical procedure reduces considerably what might be termed avoidable waste, but for modern manufacture this is not enough. It is the wastage that has previously been considered unavoidable that has to be attacked, and this brings to the fore-front the need for the operation plan.

What is the " job," and what interpretation does it bear in different circumstances ? To one man it is the unit as a whole, to another it is a definite portion of that unit whilst in the process of manufacture, while to the third it is one operation on one constituent part of the unit.

A complex organisation is, therefore, necessary to ensure the " job " being analysed efficiently. The planner must be a man of wide experience, and intimately conversant with the type and capacity of the equipment available. He must ensure that the fullest use is made of the *best* equipment so that operation times can be reduced to a minimum. In preparing his plan he must co-operate closely with the departments concerned with manufacture, and must be confident that his plan has been so well and truly prepared that there can be no doubt of its being followed when put into effect.

In the past the subtleties of production were to be found in actual manufacture ; nowadays they are to be found in the layout or plan of manufacture. If we look upon production as an edifice, we may regard the planner as the architect, and his job layout as the plan.

Thus, as far as ever possible, the supervision is relieved of the work of planning. Their duty is to do the job according to instructions, interpreting them intelligently, not blindly. This does not pre-suppose a rigid discipline for following instructions, but rather the closest co-operation between supervisor and planner, for " the builder can enhance or degrade the architects' plans, according to the manner in which he works."

(3) FACTORY LAYOUT.—The modern factory layout is planned to ensure unimpeded movement of production, which invariably means that all movements have one direction of *flow*, and that they are timed so that congestion at any point is avoided.

The subject is a wide one, and I can only, therefore, emphasise certain fundamental considerations :—

(1) Concise knowledge of the actual operations and times must be known before commencing the factory layout. These are defined by the operation plans just discussed, which, combined with the forecast of sales, usually in quantities of completed apparatus per week, determine the equipment required.

(2) The operation plan also provides the sequence of operations, and careful study must be made of all similar operations requiring the same type of machine to decide whether machines will be grouped by class, or placed in sequence according to the operations on each detail part. The usual practice is to group machine by class, thereby ensuring more expert supervision, and easier absorption of fluctuating load. Only in the case of mass production is it economical to layout by sequence of operation, and great care must be exercised to ensure full and even loading.

(3) The layout engineer is invariably given an existing building or area for the new production, and it is seldom that everything completely suits his ideal. Again his ideal may be possible in the area at his disposal, but the expense associated with these plans may be prohibitive. Consequently his final plan is usually a compromise between the ideal and the economically practicable. It is here that ingenuity can be exercised, and the seemingly impossible made possible.

(4) The best factory layout is that which will ensure the maximum output per square foot, with the best possible working conditions.

(5) The *flow* must always be in one direction, the cross-line traffic merging into the main line in much the same way as street traffic is regulated in a well-ordered city. The best tool for ensuring uni-directional flow, as well as controlling the rate of flow is, of course, the conveyor.

Conclusion.—I trust that in the short time at my disposal I have shown you that the functions of a planning department are of such scope that they can, if wisely directed, control with accuracy every phase of manufacture. To be successful, it is imperative that all members of the *team* engaged in manufacture develop the " planning sense," and have complete faith in planning as the only right method of tackling any job. This alone will ensure that our service to our customers will not be found lacking when measured in terms of the factors on which alone success in industry depends : *Time, price, and quality.*

MR. H. C. ARMITAGE (Member of Council) said that he had understood that Mr. Satchell was going primarily to refer to the planning of small quantities of work, and also that he was going to speak to some extent from the point of view of repetition or so-called mass

production. Probably some other speaker would speak from another point of view, and after that, members would be able to form their own conclusions as to whether a planning department was worth having or not.

There seemed to be a general impression—or there used to be—that planning was only applicable to quantity production. It was his firm belief that detail work-planning was more necessary in a jobbing shop than it was in a mass production factory. This was debatable, because a mass production factory could probably not survive without it, but the speaker wished to assert that it was, if possible, more vital in a jobbing shop.

This idea of planning was still comparatively new. Planning was just beginning to be discussed after the war. It certainly came after the production engineer, for most works had a production engineer long before they started thinking about organised planning. Planning had seemed to develop from the production engineer idea. When works first started planning, there was confusion of thought between planning and progress ; in fact, few people seemed to know what was a plan, and what progress. Of course progress men, or " chasers," had existed now for several generations, and were always men whose job it was to pull everything along ; their function generally was to go to the final assembly of the product, and find out what they lacked and chase it up. Now the idea of planning presupposed pushing things at the beginning rather than at the end. Therefore the first object of planning was to try and arrange that everything went uniformly forward. Speaking theoretically, if the planning were thoroughly satisfactory, no progress system should be needed.

Unfortunately, there was a difference between practice and theory, but if everything could be successfully planned without a progress system or progress men, then it might be said that the planning was 100 per cent. satisfactory. The speaker had never yet heard of anybody who had succeeded in doing without a progress system. This meant that even in the most planned factories, planning was yet far from efficient.

What are the present day types of organisation, and how does planning actually come into these organisations ? Mr. Satchell had referred to the estimating department and the planning department as being separate things, but in the speaker's opinion, plan and estimate were the same thing. If a person built up an estimate sufficiently well, he was at the same time constructing a plan. How does the planning department function with other departments ? How should it work individually ? Should it attempt to control other departments ? Should other departments control it ? What does it find its most useful work ?

To answer these questions it was necessary to go back a little to

the development of organisation. It would be remembered that, perhaps a generation ago, there had been nothing but the military type of organisation, which had grown from actual military operations. That was to say, the captain gave orders to the lieutenant, the lieutenant gave orders to the sergeant, the sergeant gave orders to the corporal, and the corporal gave orders to the men. In manager, superintendent, foreman and men would be found a parallel. In other words, the manager's was the first and last word, and everything in the works was referred up to him.

The next development arising was known as scientific management, introduced by F. W. Taylor, who started what he called functional management. Functional management meant that every man had five or six bosses. Each of these bosses was responsible for a certain class of operation ; one man looked after speeds and feeds, and another looked after material, another engagement, discipline, and so on. Thus every different operation was functionalised and specialised.

That had never caught on in England in its original form. A few attempts had been made, but were not successful, and we had taken some of those functions and grafted them on to our military organisation, and the result had been what was known as line and staff organisation. Line and staff organisation had a number of very good points about it, and he believed that at the present time America was adopting the line and staff organisation to a large extent superseding Taylorism. In the line and staff organisation, there were two parallel organisations in the works, which would necessarily be a large unit, otherwise it would hardly be worth doing. The line organisation controlled the actual performance of the work, the staff dealt with all the functions attached to it. Planning was the most effective instrument of the staff ; in other words, planning kept the line on to its job, and incidentally the line kept planning and the functional side of the staff up to its job. The result was a state of healthy rivalry, and a " dynamic " works rather than a " static " works resulted.

The function of planning would vary in all works, depending on how the works had grown up. In some cases one would find planning covered practically everything attached to the staff organisation, in other words, it was highly specialised and went into fine lines, but it was very largely a matter of what was affected by the class of work with which the firm or works was dealing. The actual result was that the plan was made by a specialised staff, and the works, or the line executives, were expected to work to that plan. There were, however, all sorts of conditions between the plan and the work ; there, were probably a dozen different people, all of whom had to take action and do their work thoroughly before the plan could be applied.

It was no good making a plan without taking steps to see that that

plan was being worked to, and that was one thing in which most modern planning efforts were failing ; the plan was there, the works were making their effort at the plan, but there was often no attempt made to find how far the plan was being worked to by the works.

Mr. Satchell had mentioned the " How, When, and Where." The " How " was comparatively easy, " Where " was even easier, but the real difficulty came in with the " When." He predicted that he would get support from Mr. Groocock in making the statement that if a works subjected itself to a plan, every individual in that works from the managing director downwards, had also got to subject himself to the plan. If the control of the works could say they wanted certain goods at a sufficient time ahead, a plan could be worked out with almost mathematical exactitude. If, however, as happened in most cases, the decision to make certain things, or the knowledge of the need for such things, only occurred two or three days before they were required, then it did not matter what plan or system was evolved, everything would go through in a haphazard way, and only a pushful progress man could get results. Planning, again, often appeared to be an overload on the overhead charges. As far as this aspect was concerned, it would be found possible, if the planning was done thoroughly, to reduce the clerical staff in the offices, and the more detailed the plan was made, the less the need for progress men, foremen, and many other classes of shop executive. If, therefore, the progress people could be diverted to planning, the sum total required would not be in excess of what would otherwise be needed. From the economical point of view, it would be found that planning was very effective. The principal reasons were that information was recorded, and every time a job recurred all the decision work left ordinarily to a foreman's judgment was easily available.

Before saying more about this, he would make reference to another point, that was, how, in a plan, one could plan to any desired degree of detail. If one said " We shall make twenty engines next week," that was in itself a plan. If, however, one said " We shall make twenty engines next week " and then brought it down further to the point at which one said " We shall make the engine bracket at 3 o'clock on Tuesday afternoon on such a machine, and such a man will be available for that job at that time," then one would, obviously, be getting out a very full plan.

In starting planning in the works, the first thing one came up against, and the worst difficulty, was always to get to know what was really needed, and to get that information sufficiently ahead. This, in a good many places, had led to sales forecasting. Planning, at the present time, had got organised ahead of the sales forecast. Unless it were possible to forecast sales to some degree, we should lose 50 per cent. of the value that would otherwise be gained by detailed planning.

MR. J. W. BERRY said he remembered, in 1915, being employed in a works where the planning department was wonderfully elaborate, and red, white, and blue tabs were used on jobs throughout the works. If any one wanted to know when a job was leaving, the only way he could find out with any assurance was to go to the shop and ask the shop foreman. That works had failed. It had a wonderful plan, and a very pretty planning department, but in the speaker's opinion, the planning department killed the works.

It was very nice in a mass production factory, with a known output, where quantities and details could be forecasted six months ahead, but he would very much like to see a planning system that could be efficiently adopted in a jobbing shop. He agreed with the principle laid down by Mr. Armitage that more could be gained in a jobbing factory if a plan could be worked to. The bugbear of the jobbing factory was that, generally speaking, one did not know from one day to another what jobs were going to be done and did not know until the order came in whether the job was a rush job or not. Under modern conditions, people waited until they were absolutely standing before they ordered, and the manufacturer was more or less forced to rush the material through the works, rather than sit down and plan his operations.

In the planning department at the works in which he was interested, they had perhaps 300 orders on the books. The whole of the orders were for the same product, but no two orders were alike ; widths varied; thickness varied ; temper varied. If one could conceive an efficient planning department for a job of that description it would certainly be a great help. Planning on jobbing and general engineering would always fail finally, because manufacturers could not forecast more than a fortnight ahead, unless they were doing contract work, and then, generally speaking, they were at the mercy of outside suppliers.

MR. I. H. WRIGHT said it seemed that there always had been planning. In the old days before the war, a man started a little business and had his own sons working about the place, and he did the necessary planning. If he succeeded, and if his business grew at all, it grew because he made reliable promises for delivery of his goods, which he could only do by planning. Later on one of his sons would be deputed to do the running about, and he became assistant manager, and so ultimately, as the business grew large he got a staff, and finally it was called the planning department, but this man had been planning all the time. As Mr. Armitage had said, planning was essential to success.

It might look in the shop, very often, as if there was no planning; as if the work was moving about, and everybody doing his job when he felt like it. Shops which really were so, however, did not last very long. Mr. Armitage had spoken about 100 per cent. efficiency

in plans, but 100 per cent. efficiency of planning meant that the planning was a failure. One could get 100 per cent. efficiency in planning by allowing double the time necessary for everybody, and would not have any grumbles from the planning point of view, but in competition, and economically, it would be very bad. The planning department should always be in trouble.—(Laughter).

However accurately operations might be planned, and however accurately one might prophesy that a certain engine bracket should be in hand at a certain hour on a certain day, there were all kinds of things, failure of power, influenza epidemics, and other things, which would interfere with that plan. In his opinion, the planning department should periodically, each week or month, consider the amount of slip in that particular week and make use of it in the following week, so that they are not getting behind all the time. He could imagine a planning department planning its work out in the shop, and it might possibly happen that in the course of a year it might be two months behind-hand, which would be rather inconvenient.

Another thing in which the planning department, in the formation of its plans, could be very useful to the management, was the reporting of the varying causes of failure in the plans. If the failure was through some mistake on its own part, then the planning department would probably not make so much noise about it, but if there was a failure in the plan or equipment, the planning department would be able to mention it in the proper quarters. It seemed, too, that often in factories where only an elementary degree of planning was carried out, the process of work, particularly where the nature of the work varied, should generally cover more than one way of making the piece. For instance, a piece might be very obviously a bar lathe job, but if the work at any particular moment was too great for the bar lathe department, then if the part was processed for some other lathe, such as a centre lathe, it would be possible to have the whole shop working the whole of the day, rather than the bar lathe working overtime.

If it were found that the amount of work which was primarily processed to the bar lathe department was always too great, and quite a lot always had to be done some other way, it would be a clear indication that the bar lathe equipment was not sufficient.

The planning which went so far as to decide at what minute a certain piece should be done might be possible, but he had no hope of ever seeing anything of that sort. It seemed to him that if the machines were arranged in departments, as Mr. Satchell had suggested, for generally varying work, undoubtedly the best method would be to allow the foreman a certain amount of latitude in changing jobs from one particular man and machine to some other, and that as the plan became more fine and detailed, of course the

foreman's liberty was reduced ; at the same time it should not be entirely cut out.

In making special machines (which were the only ones in demand now) planning had to be done as well as possible, but there were changes constantly occurring after the ordering, so that the programme had to be altered very often. It was very difficult to keep any kind of balance between the various parts of the works when the programme was being chopped and changed every week or two, and even at the time when one was really working night and day under unbalanced conditions on highly special work, there ought to be a certain amount of stock work, standard machines, etc., which could be used to fill in gaps. The planning department ought to have something to do with the distribution of that work, because, as Mr. Satchell said, the function of a planning department was to economically connect work to be done with the plant and labour available.

Mr. J. A. Hannay (Member of Council), said that Mr. Satchell and Mr. Armitage had given them plenty of food for thought, and he would just like to mention two or three points.

First of all, they should have before them the cost. Before the job was taken on by the shop, or sales, or directorate, they should have some idea of what a job was going to cost in order that the sales might make every attempt to get the business. After that, they must have an estimate of how the work could be done. These plans, or costs, were to be given before anything had been done, based on previous work. Before the job could go in the shop, they should have an estimate and make that estimate link up with the figure that was given in the first case. Then they must have a planning department to ensure that the estimate could be followed. Then the shop people must follow up, and their duty would not be to say how or when the job was to be done, but to do it. If they could not do it, then they should send for the man who planned it and said they *could* do so, and let him come and show them.

In connection with Mr. Armitage's remark about the number of staff, progress men, " chasers," and so on, who were done away with, it might interest the members to know that ten years ago a certain volume of work was being turned out in a factory in that city. To-day more than ten times the amount was being turned out, and he could say without any fear of contradiction, that progressing and chasing had not increased one-tenth. The same staff that were progressing and handling 150 chassis per week were now handling 1,500, and that was due to careful thought and planning.

We should, in these days, keep our minds on the cost ; that was everything.

He would like to say a word to those who hesitated about the jobbing shops, and the difficult jobs which came along. Those who

found excuses to show how difficult and how troublesome the jobs were, were the people who were never going to make a plan and get through it. The man who took troubles as they came and set about formulating some plan or other, and put the job through, was the man who reached success : the man who, in all sorts of difficulties, simply forced some plan forward.

He would advise everyone to see what was being done in other factories, but at the same time, if they were going to have a plan which was any good, it would have to be their own plan—not the B.T.H. plan, or the Austin plan or any other such plan. It was the man who could catch the idea behind their planning and then make use of it who was going to succeed. A plan was going to be no good unless it was their own—for their particular job.

He wanted to impress upon them that they must be individuals, that even in a little place they should stick to their individuality and make up their minds what they were going to do, and if they had only a little bit of plan to carry out, carry that out better than the planner. Having a plan, we should have a good organisation, a good designing staff, a good production staff to manufacture and carry it out, and he was convinced that the plan should come between design and production, so that the man who was producing and carrying out the work should be able to devote his time and attention to that, without stopping to think " Can this be done ? " He must see that output was kept up minute by minute, hour by hour, day by day, and at the end of the week he should have the total output required, and, if possible, more. If he was going to study how every little bit of work was going to be done, he would not get the output. We had got to the stage with some inventors where we locked them out of the works. We must simply push the plan for all we are worth, as it is laid down. Everything in the future depended on each one having an individual plan to carry out. Any man who could not do this for a jobbing shop was admitting he was defeated to start with.

Mr. J. H. Fletcher compared planning, which was so vitally important in modern engineering works, to the nerves of the human body : management, to the brain ; and the workmen, to the organs both internal and external of the human body. The brain directed the nerves, and therefore could be compared to the management, which directed the planning department ; the planning department directed the workmen, and could be compared to the nerves directing the organs. With that, we got the formula of good management, good planning good workmen, and good material, which must equal successful production.

Mr. Skeggs said he was a very humble student of planning. He did not profess to know anything about it, but it had been his privilege to be allowed to study planning organisation in works and

industries of various kinds, and he would like to state at the outset that his experience in a large motor manufacturing firm in that district had been the most interesting of all.

If he might be allowed, he would like to make one or two suggestions for the possible planning of a works of medium size, dealing with two entirely different phases of industry : firstly, the type of product which might be termed the routine product, which was being made to be sold from stock, not quite day-in and day-out the whole year round, but perhaps twenty days out of each month, roughly ; secondly, the same works was dealing with non-repeat orders, so that it might be called, from that point of view, a jobbing shop. It was necessary, therefore, to devise some means of planning that remaining-week-of-the-month job.

A plan was made covering a period of about a month ahead for the routine product, which was not a question of dealing with the same size each week, but with varied sizes of the same type of product, and specifications varied from day to day. In each plan a gap was left representing roughly 20 per cent. of the period planned, and that gap admitted the production of non-repeat, or jobbing work. They were largely dealing with presswork, planned with certain of the welding and general machining operations. The bottle-neck as a rule was in some of the principle presses, which were considerably overloaded so far as the time factor was concerned, and that was the determining factor in production.

The following procedure worked comparatively well. The plan was worked out by a small planning staff, and was then taken down to the production superintendent by a member of the planning staff who had worked out the plan for the agreement and checking by the production man. So that when their raw material arrived in the shop the production man should not say " This plan is all very well, but it is quite impossible for the production man to achieve." The plan was occasionally altered, generally to only a slight extent, to meet the production man's wishes, but by that direct personal contact between the planner concerned and the production superintendents, an atmosphere of harmony and collaboration was felt which stood them in very good stead.

Another phase which a previous speaker's remarks had brought to mind was the question of delivery of incoming material, that was the raw material, to the works concerned. The speaker had mentioned that all plans were apt to be upset by failure of the outside supplier to deliver on the date they had promised. That experience was very common, but a great deal could be done to improve a situation of that sort by co-operation between the firm ordering and the outside supplier. He had come across the type of buyer who was apt to try to take precedence of place, and the particular planning department concerned had to plan for its raw material due

dates as carefully as it did for the date objectives in its own works. A planning department responsible for giving dates to a buyer would send out some casual note or requisition giving the material required within a week or fortnight for production, instead of carefully and conscientiously working out the date the material will be needed, i.e., the day of the month. If the supplier was encouraged by the person ordering, to work to a proper schedule, as the orderer was also doing, and if the orderer saw, over a period of months, that he could place confidence in the dates that were given to him, it would be found to develop an atmosphere of confidence between orderer and supplier that would persuade the supplier, automatically, to conscientiously keep to dates. It was of great importance to all those engaged in industry that an atmosphere of that sort should be cultivated and built up.

Although he had no personal experience of the industry, an interesting case had come before him in the boot and shoe trade, which was perhaps, next to the motor trade, one of the best planned trades in the whole country. The particular works was so planned that it was one of those factories in which they could tell you where any particular shoe was at about ten minutes' notice. The number going through the works at any given time was about 200,000. Each department was given a schedule once a week. The type of shoe was described by a number, and each man had his programme worked out for every hour of every day. There was no calculating what type of shoe should be on which machine at what hour! Perhaps some gentleman present could tell them more about that particular subject.

The last point he wished to make dealt with the jobbing shop where sometimes a plan might be introduced, and where ordinary methods of planning were not applicable. Two methods, consisting of flow of work, not exactly planning in its ordinary sense, had been brought to his notice. One was rather a collaboration between the inspection department and the others, by means of an easily visible stacking of parts as they proceeded through the works, or one might say, a place for everything and everything in its place. The speaker suggested that in a jobbing shop, even if it was difficult sometimes to do that, they might have a place labelled for the product to be stacked in as it was finished, or moved from one shop to another. This would enable the chaser (if they had to employ a chaser, and if the planning did not cover all classes of goods) to know where to look for material as it was going through, and to give a forecast, based on the first two or three days' manufacture, of what was going to happen within three to four weeks on that particular order, on which to base a firm promise. The inspection department might do much the same sort of thing, using inspection figures denoting quality, instead of quantity.

In connection with a food packing firm, he had asked the planning manager if he would be kind enough to give him an idea of the problems in planning. The manager asked him "What would you do about this? Some time ago we got an order for 5,000 tins of potted partridge, and we ordered up our 5,000 partridges, expecting them to be more or less uniform. They sent me 4,000 rabbits, bearing a weight tolerance of 40 per cent. What would you do about it?"—(Laughter).

MR. R. H. YOUNGASH said that, as was usual in their discussions, they had gone very well round the subject of "What are the Functions of a Planning Department?" He would suggest that the functions of a planning department were wholly and solely those we cared to endow them with. As he had said earlier, we had divided and sub-divided our manual operations, and had now reached a stage when we were dividing the functions of management. As a production engineer, he thought he could say without any hesitation (in view of the fact that there was as yet no Institution of Planning Engineers) that the production engineer was definitely superior to the planning engineer. The production engineer should, therefore, make the planning engineer do exactly what he wanted him to do. Last year they had had a lecture on the subject of the Collection of Mechanical data, which clearly proved that they were all dependent entirely on the collection of data for all they knew about production. Later they had had a gentleman to lecture to them on Costing and Works Accounting, who had proved that they knew nothing at all about production. Whether they allowed the planning engineer to reach that stage depended entirely on the functions with which they cared to endow him. There was no doubt that planning always had been practised, and it had now reached a stage where a number of men were being set aside for the purpose of planning.

Years, ago, in what was quite a highly organised little shop, a certain kind of planning had been practised, but to separate the planning from the production would have been extremely difficult. They had, however, a system whereby work was delivered into the shops. On the requisition issued by the production people, the urgency of those parts was determined by the responsible individual, who happened to be a man who went round the shop with a supply of little red labels on which was printed "Very Urgent," and who stuck them on to the job that was very urgent. After all, crude as it might be, that was planning. It showed that that particular job had to be given attention before another one, and most probably that system existed in many cases to-day.

The question of how far they were going to let the planning department decide things for them really rested entirely in their own hands. He would quote from a little booklet issued by the

B.T.H. Company in connection with a large electric generator, as follows: "12-30.—planning department conference was in session. A complete time table was available at 4-30, showing precisely the dates on which each element of the X assembly must be completed to ensure continuity." In his opinion, that was not the function of the planning department, but of the production department. They were the people who should determine the time in which delivery was to be made. The planning department should confine their energies to ordering machines for that production.

Whether a factory had a planning department must depend on the circumstances and on the magnitude of the organisation. One could conceive a small brewery, where the production manager said to the planning manager, "On Tuesday we shall start and make Nut Brown, and on Friday we will make Pale Ale." On the other hand, if the brewery were sufficiently large, no doubt they would run a continuous plant for both of these—mass production with conveyors, etc.

It was very certain that small works could not plan to a great extent, but the planning was done, and it was just a question of terms. Instead of a foreman doing it, he might set aside a man to do that planning, who became the planning engineer, and could do exactly what the production engineer wanted done, and just as far as he wanted it done.

Mr. Armitage had referred to planning to a time table, and Mr. Wright had seemed rather sceptical. He could assure Mr. Wright that it had actually been done because he happened to be the unfortunate individual on whom Mr. Armitage had experimented. He might say that they had produced to time table for not a few, but thousands of pieces, and at a certain hour of a certain day a particular job went on to a machine. Whether that condition was worth while obtaining, was quite another matter, but he assured them it was absolutely practicable. The planning department had not yet had the courage to go into the hardening shop and say what time a piece should be in the furnace. They dealt with 250,000 to 300,000 pieces each week, and the magnitude of the programme would frighten most routine planning men. Everyone should be guided entirely in those matters by the circumstances that prevail under particular conditions.

Mr. Satchell, in answering some of the points raised, said it was very difficult, in a few opening remarks, to go fully into the subject of what were the functions of a planning department, and a lot of the points that had been raised would have been covered had more time been available.

Mr. Armitage had raised the question of the connection between planning and estimating departments. Strictly speaking, they should be one. It was a question very often of the building up of

the factory over years as to whether they were two departments. However, they must work hand in hand, and were virtually the same department.

Mr. Hannay had pointed out the necessity for having a cost. In the case of apparatus which was expected in quantities, it was absolutely essential, as Mr. Hannay had said. The proper thing was to have a plan which gave the costs available, before a price was quoted to the customer. It was their own practice in these cases to detail every single operation with the estimated cost of that operation, assuming a certain quantity; cost of set-up ; every tool required and cost of that tool, jig or fixture ; and cost of drawing that jig, tool or fixture. When the orders were received, the same sheet was used for planning, and in a column adjacent to the estimated costs, were filled in the actual prices at which the job was put out in the factory. It was usual, when estimating a cost, to err on the right side. The head of any department could plan up to that estimated cost of that item without reference to anybody, but he might not exceed that until he had first of all seen the man responsible for the plan, and it was up to that man to find another method which would meet the estimated cost. That covered the question of actually putting the work on the tool for which it was planned.

The question of type of planning organisation was a difficult one as it varied according to the size of the works or factory. There were factories where it was difficult to decide whether to have a central planning department, or alternatively a main planning department with branches in the separate sub-factories. If there was the necessity for separate planning units, it was essential that the different units should be directly responsible to the head of the sub-factory. The policy of the unit should be controlled by the main planning department, and if the mentality employed in attacking the shop methods used by the main planning organisation was right, the head of the department usually came to the planning department, rather than the planning department having to go to the head of the department and tell him what he had to do. He usually asked " Will you please give me your opinion on how best we should do it ? "

Mr. Armitage had also raised the question about the uselessness of having a plan unless the plan was carried out. That was absolutely fundamental. He would suggest that if they wanted to make certain their plan was being carried out, it was essential that the man who made the plan should personally be able to do the job he was asking others to do.

Mr. Berry had described the organisation with such a wonderful system, complete with all the coloured tabs, which was too much for it so that it eventually failed. Obviously, the system should be

the servant, and not the master. No one could take a system and sit down and try to work to that system, and expect to work to it for long. If he was alive, he would find very quickly that there were ways of improving the system, and if he knew a way of improving it, then he should change the system, but he should not allow the system to run him.

The question of the jobbing shop was, of course, a very interesting one. In his own experience, they had two different conditions of planning ; they had a jobbing shop, with which they were probably more familiar, and they had quantity production planning, in which they were just beginning to get very interested. In the jobbing shop, planning in respect of time was absolutely practicable, and it was there that the greatest value from a planning department could be obtained. After all, any job could be split up into a number of simple jobs, and each of these simple details be given a time objective. It was their practice for the time objective actually to appear on the operator's piecework ticket, and it was perfectly practicable to ensure in that way that the job, when whole and completely finished would be on time.

Speaking about one hundred per cent. efficiency in planning, it was obviously foolish to plan one hundred per cent. efficiency. In planning time for jobs, he invariably allowed eighty-five per cent. efficiency. That might appear very inefficient, but it was a figure which seemed to work out pretty satisfactorily.

The question of outside suppliers, raised by Mr. Skeggs, had also been mentioned by Mr. Berry. Here, it was his firm's practice to keep up-to-date schedule of suppliers' normal delivery times. The planner, in making out his time schedule, had to use those times. If the delivery date did not allow him to use the standard times, then he must get into communication with the supplier, through the order department, to give the supplier an opportunity of meeting the time he required. Unless he had an agreed time from that supplier, it was useless for him to plan any other time. That raised a point mentioned previously, that a plan was useless unless it was agreed by everybody concerned. The planning department did not just write a plan down on a piece of paper and throw it out into the shop ! They took it to the head of the department and explained exactly what they wanted. In nine cases out of ten they got very useful ideas which were incorporated in the plan, so that when the plan went out it was a definitely agreed one and obviously, therefore, it could be met and must be met.

The question of planning a choice of machine tools had been raised by Mr. Wright. He would explain that he had covered that by saying that they must allow the shops to use their own discretion in the case of overloading, and that was why they gave the original estimated price against the actual price at which the detail was put

out. The loading chart had not as yet been mentioned, but the problem of peaks on various classes of equipment was very readily overcome by the loading chart providing, of course, that one was not working on a delivery time which was too short to allow the chart to show up the peak. He had used load charts, and in a number of cases had shown the heads of the various departments a peak well ahead of that peak occurring. They would not believe them until after one or two failures and then they appreciated the load chart, and saw that they were of considerable value. It so happened that they decided to discontinue the load charts. The load chart was a very difficult thing to get instituted, but it was very much more difficult to get dropped by the persons responsible for production.

Mr. Youngash had asked where the planning engineer came in respect to the production engineer. In reply, he would suggest that they were the same, particularly if the planning engineer was allowed to control times. Mr. Youngash had also read a few words from a little booklet on a large motor recently completed, and he might be interested to know who were the members of that planning department conference, as it was called, and who they represented. They were : the designing engineer, the superintendent of the factory making the motor, his chief assistant, the head of the drawing office, the head of the section which would handle that work in the drawing office, the head of the order department, and a representative from the traffic department, who had got to ship the job out of the factory. And that was called a planning department conference ! It embraced every responsible individual who would handle that job at any stage throughout its manufacture. Secondly, the plan was agreed, and consequently everybody concerned was morally bound to honour his agreement.

MR. T. A. JACOBS said he would like Mr. Satchell to explain what he meant when he said he got eighty-five per cent. efficiency. Did he mean eighty-five per cent. efficient on the planning estimates, or eighty-five per cent. efficient on actual production ? The reason he asked was that a few years ago an investigation had been arranged to take place in a few well-organised factories to find out what the amount of efficiency was. The investigation had shown that no department could show more than sixty per cent. efficiency. On another occasion, a lecture had been given by a member of a well-known Manchester engineering firm. This firm claimed to be very efficient in its organisation for production, but it had been shown by the lecturer that the efficiency varied from thirty-five per cent. to sixty per cent.

MR. SATCHELL, in reply to Mr. Jacob's query, said that the eighty-five per cent. was eighty-five per cent. of actual experience, that was, of the actual time taken to do the job. In setting any piece-

work price, allowance was always made, ten per cent. or fifteen per cent. was normal. The eighty-five per cent. which they allowed was the eighty-five per cent. of the time which had been found by experience to be sufficient for a quantity of that particular job. One might say they kept something up their sleeve, from the point of view of the time chart, because it would be usually found that the efficiency was somewhat higher than eighty-five per cent., as they had already allowed all contingencies in arriving at the actual time.

Mr. W. G. Groocock, on being called upon by the president to wind up the discussion, said that before we could really visualise the functions of a planning department we must have a clear idea of the connection between the planning department and the works management, and we ought, therefore, to ask ourselves—What is a planning department ? In his opinion it is a tool that the manager puts into his organisation to carry out certain ideas, and to be effective the planning department must be a machine. If it is to be successful, however, it must be a machine with a soul ; a machine with understanding and with reasoning powers, so that as and when necessary it could alter its plans to meet varying conditions. When a planner has devised a plan he must not sit down and say—Now I have done my job. This is the way to failure. The true planning department follows the plan through the shop, ever ready with help from its specialists to those on the works' staff who require advice of any description. All departments in a works were there definitely for one specific purpose, namely, to give service to their customers, and it was the function of the planning department to so co-ordinate the various sections that all were working towards the desired end mentioned by Mr. Satchell, namely, a thorough control of the factors : time, price, and quality.

A further very serious factor which he would himself place first was that of atmosphere, and he ventured the opinion that it was one of the vital functions of a planning department to create such an atmosphere that everyone had what Mr. Satchell had described as " planning sense." What was the necessity for the creation of such an atmosphere ? He ventured to think it was clarity in direction. Most of the members had had trouble in driving a car through the streets during foggy weather when visibility was bad and sense of direction was almost lost. We know under such circumstances it takes a long time to move between two points. The same thing exists in many works, and it was the function of a planning department to see that visibility was good and the sense of direction was also good. Under such conditions we could then be sure of getting production in a minimum time.

The three factors mentioned by Mr. Satchell : quality, price, and time, rather gave us a key to what are the functions of a planning department. If a planning department had to ensure that these

three factors were properly attended to, then it is quite clear that they would have to go right through the whole range of the product in some form or other, touching first the design, second the material, third the methods of producing the work, and fourth and finally, seeing that the whole of the necessary operations of design, purchase of material, and the production itself, were done in time. This meant that their functions would include close touch with the drawing office, and also with the purchasing department, even if they did not control them. The layout of operations was understood, and this implied also provision of jigs and tools necessary.

All these then were functions of a planning department. Just how far they went in each particular case depended on the charter that was given to them by the management. Thus, the quality of the product was laid down by the management, and it was interpreted for them by the inspectors. Although the planning department could not—and should not—interfere in this matter, there must be close co-operation between the planning department and the inspection, particularly if the planners also had something to do with the design and the ordering of material. In the majority of establishments planners would not have control of design, but they must be closely in touch to see that the design is suitable for production ; to see also that the materials asked for are such that the machinery at their disposal can work it and still give a satisfactory product.

Coming to price, it was the function of the planning department to see that the price allowed could be achieved, and this meant that there must either be control of all operations that affected the price, or close co-operation. When we come to think over the question of price, there are a number of interrelated steps, or functions, which must be considered in parallel, such as design and cost of material, design and cost of labour. There are also machining operations and cost of material, machines available and the cost of labour. In most cases, too, overheads had to be considered. All the above had to be studied when making out a schedule, so that the factory could produce a good article at the price required.

On the question of time, which is particularly important these days, if the time taken was too long the order was lost. If the order was taken on a given time basis and the work was not delivered, then we had dissatisfied customers. It was up to our planning department to know exactly what they could do in the way of time and see that the works lived up to it. When we come to summarise the various heads we find it is impossible to satisfactorily answer the question of : What are the Functions of a Planning Department ? unless we can standardise the organisations in the various works. These functions depend absolutely on what the works management wants their planning department to do.

Mr. Groocock concluded by thanking Mr. Satchell.